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ENVIRONMENTAL RESTORATION
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Los Alamos National Laboratory **Environmental Restoration Project** **Standard Operating Procedure**	No: LANL-ER-SOP-4.01 Rev: 1

DRILLING METHODS AND DRILL SITE MANAGEMENT

Prepared by	Jon C. Newsom (Print Name)	C.N Newsom (Signature)	11-20-96 (Date)
Quality Review by	Dave Bradbury (Print Name)	D Bradbury (Signature)	3/17/7 (Date)
Technical Review by	Greg Bayhurst (Print Name)	Greg Bayhurst (Signature)	11-22-96 (Date)
PM Approval	JORG JANSEN (Print Name)	Jorg Jansen (Signature)	5-5-97 (Date)
QPPL Approval	Larry Maassen (Print Name)	Larry Maassen (Signature)	4-28-97 (Date)

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Drilling Methods and Drill Site Management

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Drilling Methods and Drill Site Management

1.0 PURPOSE

The purpose of this procedure is to describe drilling methods that may be used during environmental restoration (ER) field effort and to define the measures necessary for implementing a Drilling Package to meet the subsurface sampling requirements for a Resource Conservation and Recovery Act (RCRA) facility investigation (RFI).

2.0 SCOPE

2.1 Applicability

This procedure is applicable to field activity associated with ER Project, the field project leader (FPL), and to Laboratory or contractor personnel involved with planning, designing, and/or constructing RFI Boreholes and monitoring wells.

2.2 Training

The FPL is responsible for ensuring the proper implementation of this procedure. The field team leader (FTL) and other personnel involved with these types of activities should be familiar with these objectives and document that they have read and understand this procedure and the procedures in LANL-ER-SOPs in Section 1.0, General Instructions.

3.0 DEFINITIONS

A. Auger Flights: Winding metal strips welded to the auger sections that carry cuttings to the surface when the auger is rotated.

B. Bentonite: A hydrous aluminum silicate in powder, granular, or pellet form that when hydrated provides a tight seal between the well casing and the borehole wall. Bentonite may also be used in a 2 % to 5 % mixture with Portland cement to form a grout seal that expands as the material hardens.

C. Casing: A solid piece of pipe, typically steel, stainless steel, or PVC plastic used to keep a well open in either unconsolidated materials or unstable rock, and as a means to contain zone isolation materials such as cement grout and bentonite.

D. Cutter Head: An auger bit that is attached to the leading auger flight section and cuts a hole for the auger to follow. The bit may be either a coring head or a full face bit.

E. Drill Bit: The cutting tool attached to the bottom of the drill stem.

F. Drill Rods or Drill Pipe: Special pipe used to transmit rotation and energy from the drill rig to the bit. The conduit which conveys circulation fluids such as air, water, or other mixtures to cool the bit and evacuate the borehole cuttings.

G. Drilling Package: A detailed Drilling Plan, Curation Plan, Sampling and Analysis Plan (SAP), and Geophysical Logging Plan. This package is prepared by the FPL or FPL's representative and is approved by the Subsurface Technical Team.

H. Daily Drilling Report: The primary record of daily drilling activity supplied by the drilling subcontractor. The FPL or designate is responsible for the confirmation that reports are accurate before forwarding to Subsurface Technical Team.

I. Grout: Cement or hydrated bentonite mixtures used in sealing of boreholes or wells, and for zone isolation.

J. Reamer: A type of drill bit that is used specifically for enlarging a borehole.

K. Shelby Tube Sampler: A thin wall tube sampler latched into the lead auger while hollow stem augering or pushed/driven ahead of the auger.

L. Split Spoon: A core barrel that can be opened to remove samples. This is a sampling method commonly used with auger drilling. The split spoon sampler can be driven into the ground or can be advanced inside hollow stem augers.

4.0 BACKGROUND AND/OR CAUTION

Various drilling methods have been developed to achieve successful subsurface contact for retrieving suitable formation, gas and water samples. These include but are not limited to solid-stem augering, hollow-stem augering, direct rotary, reverse rotary, and cable tool drilling. Because geologic conditions range from hard rock to unconsolidated sediments, and environmental concerns are consequential, some drilling methods may be more appropriate than others.

4.1 Drilling Methods

4.1.1 Hollow-Stem Augering

The hollow stem auger is a section of seamless steel pipe. The auger flights are welded to the pipe and act as a screw conveyer to bring the cuttings to the surface. The drill rods, split spoon core barrels, Shelby tubes and other samplers can pass through the center of the hollow stem auger sections. The samplers may be positioned and retrieved via wireline for continuous or intermittent coring while augering.

The lowest flight in an auger drill string or lead auger is equipped with a cutter head. The lead auger can have either a core barrel or center plug locked on to it. The core barrel can be used to obtain core as the auger is advanced. A center plug is sometimes used to prevent cuttings from coming up inside the auger.

Auger sections are typically 5 ft in length and have outside diameters of 4 1/4 to 14 in. (2 1/4 to 10 in. inside diameter). At Los Alamos depths up to 350 ft have been drilled using hollow stem augers.

Hollow stem augers can be used as temporary casing when setting wells to prevent caving of the borehole walls.

4.1.2 Direct Rotary Drilling

The air rotary drilling method works on a principle similar to the more common mud rotary method except that air is used to lift the cuttings from the borehole. A large compressor is used to force air down the drill rods where it passes through ports in the drill bit. As the bit cuts through the formation, cuttings are discharged to the surface and are collected in a dust suppression system. In some harder formations, a down-the-hole hammer (DTH) may be substituted for a roller cone bit. Compressed air is used to drive the DTH.

The Odex method is an adaptation of the air rotary method that uses a casing driving (advancing) technique in conjunction with air rotary. With the Odex system the drill bit extends outward to ream a larger hole than the casing. The casing is advanced into the hole by means of percussive energy while simultaneously drilling the hole. Because of the unconsolidated and poorly welded tuff found at Los Alamos, the Odex method provides the necessary casing to stabilize the borehole as it is drilled.

Air rotary coring is intermittently performed ahead of the ODEX system. The core barrels have been specially designed for limited contact with the compressed air.

At Los Alamos air rotary drilling is done with the dual wall reverse method. This system is generally used in boreholes having a depth greater than 300 ft.

4.1.3 Hand Augering

Hand augers may be used to bore shallow holes (0 to 15 ft). A typical hand auger is advanced by turning into the soil until the auger is filled. The auger is then removed and the sample is dumped from the auger. Motorized units for one or two operators are available and can reach depths up to 30 ft under certain conditions. Better formation samples can be obtained by the use of a thin wall sampler in conjunction with the hand auger. Refer to LANL-ER-SOP 6.10, Hand Auger and Thin Wall Tube Sampler for detailed instruction on the use of this type of technique.

4.2 Cautions

Health and safety precautions involve monitoring all material coming out of the borehole as well as the air exiting the dust suppression system using portable field screening instruments.

Due to close contact with complex drilling machinery in motion, only drilling subcontractors should operate the equipment to prevent accidents.

Site workers should read and understand the Health and Safety Plan (HASP) for the site and be aware of drilling operations at all times.

All waste generated should be handled in accordance with LANL-ER-SOP-1.06, Management of Environmental Restoration Project Waste.

5.0 EQUIPMENT

- Drill rig and accompanying equipment
- Casing
- Grout, cement and bentonite as needed
- Core barrels
- Any additional supplies listed in associated procedures
- Equipment specified in the HASP
- Dust suppression system, if air rotary drilling to be performed

6.0 PROCEDURE

Operation of the drill and equipment must be in accordance with applicable industry standards and regulatory requirements, and LANL ER Project SOPs or Administrative Procedures (APs).

6.1 Preparation

A. Prepare and submit a Drilling Package to the LANL Subsurface Technical Team for review and approval. The Drilling Package consists of a detailed Drilling Plan, Curation Plan, Sampling and Analysis Plan (SAP), and Geophysical Logging Plan. The Drilling Plan contains detailed information on drilling requirements, methods, and objectives. Refer to LANL-ER-SOP-5.01, Monitoring Well and RFI Borehole Construction for detailed requirements. The

Curation Plan provides details on planned core recovery and archiving as specified in SOPs in LANL-ER-SOPs in Section 12.0, Curatorial Management Activities.

SAPs are based on sampling requirements described in the site Work Plans. The SAP must also describe sample handling and decontamination between samples. If geophysical logging is needed, then a Geophysical Logging Plan must also be submitted.

B. Ensure that all permits and approvals found in LANL-ER-AP-05.1, Readiness Review for Environmental Restoration Project Field Activities, are obtained.

C. Schedule all drilling rigs and associated equipment with the Subsurface Technical Team prior to going out in the field. Schedule all geophysical logging and other drill hole testing as appropriate.

D. Have all necessary work site preparations completed before drilling begins such as: brush and minor obstructions removal, access roads cleared, and borehole location properly staked. Ensure that drilling areas are not traversed by utility transmission lines.

E. Prepare for the collection of potentially hazardous borehole materials. Refer to the SOPs in Section 1.0, General Instructions and LANL-ER-SOP-1.06, Management of Environmental Restoration Project Waste, for detailed information and guidance.

6.2 Operation

A. Ensure that all drilling operations are carried out as specified in the site specific Drilling Package unless otherwise directed by the FPL or designate. The termination or modification of any boring must be in accordance with the Drilling Package or approval by the FPL and documented accordingly. All changes must be reviewed by the Subsurface Technical Team before implementation.

B. If coring is specified, use appropriate core barrels and samplers (refer to LANL-ER-SOP-06.26, Core Barrel Sampling for Subsurface Earth Materials). The site worker is to take possession of the core and handle it in accordance with the Curation Plan and appropriate LANL-ER-SOPs, Section 12.0, Curatorial Management Activities (if applicable).

C. Ensure that all samples are taken as specified in the site specific SAP. All sampling equipment must be decontaminated as described in the SAP and in accordance with LANL-ER-SOP-01.08 Field Decontamination of Drilling and Sampling Equipment.

D. Field screen all borehole materials for hazardous and radioactive constituents as described in HASP. All the previsions found in the site specific HASP for handling hazardous material must be followed.

E. Ensure that all appropriate forms are completed as per LANL-ER-SOPs in Section 1.0 General Instructions, and LANL-ER-SOPs in Section 12.0, Curatorial Management Activities.

F. Monitor the collection and storage of all excess cuttings, waste materials and decontamination solutions for proper disposal as described in LANL-ER-SOP-1.06, Management of Environmental Restoration Project Waste.

6.3 Post-operation

A. Ensure that all drill site equipment is accounted for, decontaminated, and ready for shipment to the next site.

B. Make sure all borehole locations are properly marked, recorded, and location identification is readily visible on the location stake. Borehole identification (FIMAD designation) and survey location should be recorded on the protective casing by use of welding rod or in concrete pad at site.

C. Ensure that the site is restored to pre drilling conditions or as specified in LANL-ER-SOP 05.01, Monitoring Well and RFI Borehole Construction.

D. Record all final construction details or borehole abandonment information as described in LANL-ER-SOP 05.01, Monitoring Well and RFI Borehole Construction.

7.0 REFERENCES

Procedures directly associated with this procedure that should be reviewed prior to drilling are:

LANL-ER-SOP-1.06, Management of Environmental Restoration Project Waste
LANL-ER-AP-5.1, Readiness Review for Environmental Restoration Project Field Activities
LANL-ER-SOPs in Section 1.0 General Instructions
LANL-ER-SOPs in Section 12.0, Curatorial Management Activities
LANL-ER-SOP-05.01, Monitoring Well and RFI Borehole Construction
LANL-ER-SOP-06.10, Hand Auger and Thin Wall Tube Sampler
LANL-ER-SOP-06.26, Core Barrel Sampling for Subsurface Earth Materials
Environmental Monitoring Systems Laboratory, 1989, Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells. EPA 600/4 - 89/034.

8.0 RECORDS

The FTL is responsible for transferring all appropriate records generated under this procedure to the ER Records Processing Facility and/or other centers as required. The records include the following records and/or forms.

Completed Daily Drilling Reports
Completed Daily Activity Logs
Completed Records LANL-ER-SOP-12.01 Field Logging, Handling, and Documentation of Borehole Samples
Completed Records LANL-ER-SOP-12.02 Transportation, Receipt, and Admittance of Borehole Samples for the Sample Management Facility
Completed Records LANL-ER-SOP-Section 1.0, General Instructions
Completed Monitoring Well Completion Information Form LANL-ER-SOP-05.01
Completed Monitoring Well and RFI Abandonment Form LANL-ER-SOP-05.03

9.0 ATTACHMENTS

Attachment A - Applications and Limitations of Drilling Methods
Attachment B - Daily Drilling Summary
Attachment C - Equipment and Supplies Check List for Drilling

Los Alamos National Laboratory Environmental Restoration
APPLICATIONS AND LIMITATIONS OF DRILLING METHODS

Hand Augering

Applications or Advantages
- For very shallow boreholes
- Can be used in tight quarters
- Inexpensive
- Rapid mobilization - little field support needed
- For overburden and soft soils sampling

Limitations
- Unable to penetrate hard rock
- Borehole stability problems
- Labor intensive
- Shallow boreholes only

Hollow Stem Augering

Applications or Advantages
- For holes less than 350 feet deep
- Good core recovery
- Can serve as temporary casing
- Much less expensive than air rotary drilling where applicable
- Good formation samples
- Can be used with continuous core sampler, with driven, or pushed samplers

Limitations
- Requires field support
- May require site preparation
- Sometimes a dust hazard
- Can not penetrate hard formations or boulders
- Hole depths to only 350 feet
- May redistribute contaminate up the borehole

Air Rotary Core / Odex Casing Advance Drilling

Applications or Advantages
- Generally for boreholes greater than 300 feet
- Casing eliminates borehole collapse and contaminate spread
- Good core recovery
- Rapid advancement possible
- Eliminates contamination of borehole and samples by drilling fluids (other than clean dry air)
- Depths greater than 1200 feet are possible

Limitations
- Samples can be pulverized
- Air may modify chemical conditions
- More expensive than auger drilling method for shallow holes
- Dust control required
- Requires more field support and site preparation than auger drilling

Los Alamos National Laboratory Environmental Restoration
DAILY DRILLING SUMMARY

Date: _____ Sheet _____ of _____

Technical Area _____ Operable Unit _____

Site Work Plan: _____

Signature: _____

BOREHOLE INFORMATION

Borehole ID	Drilled Interval	Shift Start Date	Shift Time	Completed By	Date	Checked By	Date

SUMMARY OF ACTIVITIES _____

GEOLOGIC INFORMATION _____

RUN INFORMATION

#	Interval	Cut	Recovered	Unrecovered	Unrecovered Interval	% Recovered	Verified By
TOTAL							

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EQUIPMENT AND SUPPLIES CHECK LIST FOR DRILLING

	GENERAL
_____	Hard hat
_____	Safety glasses
_____	Gloves
_____	Steel-toed boots
_____	Hearing protection
_____	Coveralls
_____	Sample containers
_____	Appropriate clothing
_____	Sprayer with clean potable water for dust control
_____	Any applicable licenses and permits
_____	Camera and film
_____	Measuring tape (tenths)
_____	Plastic sheets
_____	Core boxes
_____	Polystyrene core cradles
_____	Large black permanent marker
_____	Strapping tape
_____	Hand knife
_____	Rock hammer
_____	Any additional supplies listed in associated procedures, as needed, or equipment specified in the Health and Safety Plan

	ADDITIONAL SITE-SPECIFIC ITEMS
_____	_____
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